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**LHC Interaction Region Quadrupole Cryostat
Vacuum Vessel Material Specification**

Fermilab Specification: 5520-ES-390105

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LHC Interaction Region Quadrupole Cryostat Vacuum Vessel Material Specification

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1.0 Scope.

- 1.1 This specification defines the minimum requirements for materials used in the fabrication of vacuum vessels for the LHC interaction region quadrupole cryostats being fabricated at Fermilab in Batavia, Illinois for installation and use at the European Organization for Nuclear Research (CERN) in Geneva, Switzerland.
- 1.2 This specification applies to materials supplied as seamless or welded pipe sections, cylinders formed from plate, and to the weld material joining those sections. It does not apply to end flanges, access ports or other attachments unless so specified.

2.0 Minimum material requirements.

- 2.1 The base material must have a minimum yield strength of 36,000 psi (248 MPa) with an elongation not less than 18%.
- 2.2 A standard Charpy impact test must be performed per ASTM E 29 at room temperature and at -50 °C on samples taken from each lot of material. Samples must be taken from the base material, heat-affected zone, and weld metal. If the material is supplied as plate, tests of the heat-affected zone and weld metal may be performed on samples taken from welds representative of those in the vacuum vessel assembly. Where applicable, samples must be tested in the transverse direction. A minimum energy absorption of 21 J/cm² and an average energy absorption of 28 J/cm² shall be obtained over each group of 3 samples.
- 2.3 The material must be weldable to 300 series stainless steel.
- 2.4 The material must be compatible with long-term operation at room temperature and internal pressure of 1.1×10^{-4} Pa.

3.0 Material certifications and test results.

- 3.1 Material certifications must be provided to the responsible Fermilab contract administrator for each heat of material and each lot of weld material. These reports must include the material designation, results of yield and tensile tests, and chemical analysis.
- 3.2 All material test results including, but not limited to, the Charpy impact tests, must be provided to the responsible Fermilab contract administrator. The sample for which test results apply must be identifiable using information contained in those reports.